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A MOST WONDERFUL TOOL.

By JOHN H. KLOPPER, Topeka.

THE amazing adaptability of the steel square to the solving of a thousand and one problems in mathematics which puzzle the carpenter, will surprise those who know the square only as an instrument of measuring and squaring of boards and timber, and trying up angles.

In conjunction with the square it will be necessary to have a good four-fold, two-foot rule, with the duodecimo or twelfth scale marked on one of its outer edges. The outer edge of one side of the steel square, on both the tongue and blade, has each inch divided into twelfths. This is the side which will be mostly used, as each inch will represent one foot, and each subdivision one inch, or a scale of one inch to the foot.

The standard steel square has a blade 24 inches long and 2 inches wide, and a tongue 14 to 18 inches long, $1\frac{1}{2}$ inches wide. The blade is exactly at right angles with the tongue, and the angle formed by them is an exact right angle or square corner.

A proper square should have the ordinary division of inches, half-inches, quarters and eighths, and often sixteenths and thirty-seconds. Another portion of the square is divided into twelfths of an inch; this portion is simply a scale of twelve feet to an inch, and is used for any purpose, as measuring scale, drawing, etc. The diagonal scale on the tongue near the blade, often found on squares, is thus termed from its diagonal lines. However, the proper term is centesimal scale, for the reason that by it a unit may be divided into 100 equal parts, and, therefore, any number to the one-hundredth part of a unit may be expressed.

In this scale A-B is one inch; then, if it be required to take off $\frac{73}{100}$ inch, set one foot of the compass in the third parallel, under 1 at E, extend the other part to the seventh diagonal in that parallel at G, and the distance between E and G is that required. For E-F is one inch and F-G 73 parts of an inch. Upon one side of the blade of the square running parallel with the length will be found nine lines divided at intervals of one inch into sections or spaces by cross-lines. This is the plank, board and scantling measure. On each side of the cross-lines referred to are figures, sometimes on one side of the cross-line and often spread over the line, thus: 1/4-9/-. We will suppose we have a board twelve

feet long and six inches wide. Looking on the outer edge of the blade we find 12; between the fifth and sixth lines under 12 will be found 12 again. This is the length of the board. Now follow the space along towards the tongue till we come to the cross-line under 6 (on the edge of the blade), this being the width of the board; in the space will be found the figure 6 again, which is the answer in board measure, namely, six feet.

On some squares will be found on one side of the blade nine lines, and crossing these lines diagonally to the right are rows of figures, as seven 1's, seven 2's, seven 3's, etc. This is another style of board measure, and gives the feet in a board according to its length and width.

In the center of the tongue will generally be found two parallel lines, half an inch apart, with figures between them; this is termed the brace rule. Near the extreme end of the tongue will be found 24-24, and to the right of these 33-95. The 24-24 indicates the two sides of a right-angle triangle, while the length of the brace is indicated by 33-95. This will explain the use of any of the figures in the brace rule. On the opposite side of the tongue from the brace rule will generally be found the octagon scale, situated between the central parallel lines. This space is divided into intervals and numbered thus: 10, 20, 30, 40, 50, 60. Suppose it becomes necessary to describe an octagon ten inches square: draw a square ten inches each way and bisect the square with a horizontal and perpendicular center line. To find the length of the octagon line, place one point of the compasses on any of the main divisions of the scale and the other leg or point on the tenth subdivision. This length being measured off on each side of center lines, touching the line of the octagon, will give the points from which to draw the octagonal lines. The size of the octagon must equal the number of places taken off from the tongue by the compasses.

We shall now proceed to lay off the lengths, cuts and bevels for the timber in a hip roof 24 feet wide by 32 feet long, the hips to be at right angles and the roof to have a pitch of 45 degrees, leaving a ridge of 8 feet, the distance from the plate to the center of the roof being 12 feet, and the rise of the roof being the same, measure with the rule diagonally across from tongue to blade on the outside edge having the twelfth scale from 12 to 12. The distance on the rule will be 17 inches, or feet, the length of common rafter, and the figures 12 by 12 will mark the heel or seat cut, and also the plumb cut against the ridge board. It will be noticed that every foot gains five inches on the diagonal. Next

the length of the hip rafter is wanted. Measuring from 17 on blade to 12 on tongue (17 representing the length of common rafter, and 12 the inward distance of the hip from plate to ridge, the hip being the diagonal of these), the distance as shown on the rule will be $20\frac{1}{2}$, or 20 feet 10 inches. For the heel or seat cut take 12 x 17 on the square, and lay on the side of the timber and mark on the blade or 17-inch end, and on the tongue or 12-inch end for the plumb cuts. For the side cuts against the ridge board take 17 and $20\frac{1}{2}$ and lay across the upper edge of the stick and mark on the $20\frac{1}{2}$ edge. For the backing of the hip rafter dress a portion of its upper edge with a jack plane, and run a gage on its center; lay the square on with the length of the hip rafter or $20\frac{1}{2}$ on the blade and 12 (the rise of the rafter) on the tongue; mark from the gage line to edge of timber on the tongue or 12-inch end, and then from the same point on center gage square straight out to the same edge; the difference between the two points at the edge of timber will be the distance to gage down on each side of the timber for the backing. Or, a bevel can be set to the scribe made on the top as described, and worked to. The rafter should not be backed until all the necessary framing of it is done. The next thing in order will be the framing of the jack rafters to fit in their places against the hip rafter. We will suppose that the rafters are spaced every two feet on the plate, and as we have seen that every foot gains five inches on the diagonal we know that each jack will be two feet ten inches longer as they range out from the angle of the plate. Dress off the upper edge of one of the common rafters, and allowing first for one-half the thickness of the hip rafter, space off a jack rafter every two feet ten inches on said common rafter. This will give the pattern or length for cutting every set of jacks. The side cut or bevel for the jack will be marked from the longest point by the figures 17x12 on the square; the plumb cut will be the same as that of the common rafters. To miter a purlin over or against a hip rafter, take 17 on the blade and 12 on the tongue and lay on the upper edge of the purlin in the direction of your cut, but this time scribe a mark on the 12-inch edge of the square; then turn the timber on its side, lay on the figures, and mark precisely the same way with the same figures, and the miter will be perfect, as you can test by taking the piece sawed off and reversing it against the cut; it will form the correct pitch and angle. If the roof is of different pitch, then different figures will have to be used, but the principle is the same. Supposing the roof has a rise of nine inches to the foot: if you

measure across the square from 12 on the blade to 9 on the tongue you will find 15 on the rule. Take 12 on the tongue and 15 on the blade, make the cutting mark on the purlin on the 12-inch edge, lay the timber on its side, and take 9x15 on the square, lay on, and mark across on the 9-inch edge, and the miter will be marked complete. So it will be seen that the figures which govern the pitch of the common rafters must be kept in mind all through.

A little practice with the problems above set forth will make the beginner familiar with the methods and enable him to comprehend the principles. The above will work out any problem of cuts in the framing of an ordinary roof. For the more complicated problems, such as cuts for irregular hip roofs, bevels of hoppers, cutting spring moldings, etc., a deeper study into the principles of the square is necessary.